

**METHODS OF SAMPLING AND TESTING**  
**MT 407-05**  
**METHOD OF TEST FOR HIGH-STRENGTH BOLTS**

**1 Scope:**

- 1.1 The method covers rotational capacity testing of high strength bolts used in bridge construction.

**2 Referenced Documents:****2.1 AASHTO:**

M 164 (M 164M), High-Strength Bolts for Structural Joints

M 291 (M 291M), Carbon and Alloy Steel Nuts

M 292 (M 292M), Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both

**Procedure A: (Long Bolts in Tension Calibrator)****3 Apparatus:**

- 3.1 A Skidmore-Wilhelm calibrator for measuring bolt tension, of sufficient capacity for the bolts to be tested.
- 3.2 Calibrated torque wrench.
- 3.3 Spacers and/or washers with a maximum hole size  $\frac{1}{16}$  in. (2mm) larger than the bolt to be tested.
- 3.4 A steel section on which to mount the bolt calibrator. The flange of a girder or a cross-frame accessible from the ground is acceptable.

**4 Procedure:**

- 4.1 Use black fasteners oily to the touch at testing. Clean all weathered or rusty fasteners of all rust and re-lubricate prior to testing. Lubricate all galvanized fasteners with a visible dye, so a visual check verifies the lubricant's presence.
- 4.2 Measure the bolt length, not including the head.
- 4.3 Thread a nut onto the bolt with sufficient spacers or washers to bring the bolt end to at least flush with the tightened nut to a maximum bolt stick-out of three threads. Provide 3 to 5 threads between the inside faces of the nut and the bolt head. Always use a hardened washer under the nut.
- 4.4 Tighten the nut with a wrench to produce the appropriate snug tension from Table 1, with an allowable error range from 0 kips to +2 kips (0 to + 9 kn). The snug condition should be the normal effort applied with a 12-inch wrench.

Table 1

Bolt Dia. (in.)	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	1 $\frac{1}{8}$	1 $\frac{1}{4}$	1 $\frac{3}{8}$	1 $\frac{1}{2}$
Snug Tension (kips)	1	2	3	4	5	6	7	9	10

  

Bolt Dia. (mm)	20	22	24
Snug Tension (kN)	13	18	23

**4 Procedure:** (continued)

**4.5** Match-mark the bolt, nut and face plate of the calibrator.

**4.6** Using the torque wrench, tighten the nut to at least the tension in Table 2. Record the bolt tension and the torque that produced the tension. (Measure the torque with the nut in motion). Calculate the following value for maximum allowable torque given by:  $T = 0.25 PD$ , where P = tension in lbs. (N) and D = diameter of bolt in feet (m).

The fastener assembly fails the test at this point if the recorded torque exceeds the value, T, as calculated above.

Table 2

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Tension (kips)	12	19	28	39	51	56	71	85	103

  

Bolt Dia. (mm)	20	22	24
Tension (kN)	125	173	227

**4.7** Tighten the nut further by the number of turns shown in Table 3, using the radial lines on the calibrator faceplate for reference. The rotation is measured from the initial marking in step 4.5. Record the bolt tension. Bolt and nut assemblies which strip or fracture before achieving the full rotation have failed the test.

Table 3

Bolt Length	4 x bolt dia. or less	Greater than 4 but no more than 8 x dia.	Greater than 8 x dia.
Required Rotation	2/3	1	1 1/6

**4.8** Compare the bolt tension recorded from Section 4.7 with the appropriate value from Table 4. Fastener assemblies that do not provide the minimum required tension shown in Table 4 at the rotation shown in Table 3 have failed the test.

Table 4

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Tension (kips)	14	22	32	45	59	64	82	98	118

  

Bolt Dia. (mm)	20	22	24
Tension (kN)	142	200	262

**4.9** Remove the nut and bolt from the calibrator and examine them. The fastener assembly has failed the test if threads show signs of stripping, shear or torsion failure or the nut fails to turn freely, by hand, on those threads occupied by the nut in the test position. (The nut does not have to freely turn the entire length of the thread to pass this test.)

**Procedure B (Bolts too short for tension calibrator)****5 Apparatus:**

**5.1** Calibrated torque wrench and hand wrenches.

**5.2** Spacers and/or washers with a maximum hole size 1/16 in. (2mm) larger than the bolt.

**5.3** A steel section with holes sized 1/16 in. (2mm) larger than the bolt diameter, with a plate thickness that will accommodate section 6.3.

**6 Procedure:**

- 6.1** Use black fasteners oily to the touch at testing. Clean all weathered or rusty fasteners of all rust and re-lubricate prior to testing. Lubricate all galvanized fasteners with a visible dye, so a visual check verifies the lubricant's presence.
- 6.2** Measure the bolt length, not including the head.
- 6.3** Install the fastener assembly in the steel plate with sufficient spacers or washers to bring the bolt end out at least flush with the tightened nut, to a maximum bolt stick-out of three threads. Provide three to five threads in the length of bolt between the inside faces of the nut and bolt head. Always use a hardened washer under the nut.
- 6.4** Snug the bolt by applying no more than 20% of the torque allowed in Table 6 below, using a torque wrench. Measure and record the torque (with the nut in motion) on the bolt.
- 6.5** Match-mark the nut, bolt and plate.
- 6.6** Tighten the nut with the torque wrench by the number of turns from Table 5. Use a hand wrench to ensure that the bolt does not turn. Measure and record the torque with the nut in motion.

Table 5

Bolt Length	4 x bolt dia. or less	Greater than 4 but no more than 8 x bolt dia.
Required Rotation	$\frac{1}{3}$ turn	$\frac{1}{2}$ turn

If the measured torque from section 6.6 exceeds the appropriate value from Table 6, the fastener assembly has failed the test. Assemblies that fail prior to completing this rotation, by stripping or fracture, fail the test.

Table 6

Bolt Dia. (in.)	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	1 $\frac{1}{8}$	1 $\frac{1}{4}$	1 $\frac{3}{8}$	1 $\frac{1}{2}$
Torque (Ft/lbs)	150	290	500	820	1230	1500	2140	2810	3690

  

Bolt Dia. (mm)	20	22	24
Tension (N-m)	710	1100	1570

- 6.7** Tighten the nut further by the appropriate number of turns from Table 7, using the reference mark from section 6.5. Assemblies that fail prior to completing this rotation, by stripping or fracture, fail the test.

Table 7

Bolt Length	4 x bolt dia. or less	Greater than 4 but no more than 8 x bolt dia.
Required Rotation	$\frac{2}{3}$ turn	1 turn

- 6.8** Remove the nut and the bolt from the plate and examine them. The fastener assembly has failed the test if threads show signs of stripping, shear or torsion failure or the nut fails to turn freely by hand, on those threads occupied by the nut in the test position. (The nut does not have to freely turn the entire length of the thread to pass this test.)

**7 Report:**

- 7.1** Date tested,
- 7.2** Name of tester,

**7**      **Report:** (continued)

**7.3**      Procedure performed (A or B),

**7.4**      Bolt length,

**7.5**      Bolt tension,

**7.6**      Bolt torque at tension.